# APPARATUS AND METHODS FOR CLEANING ROLLERS

## Background of the Invention

### Field of the Invention

**[0001]** This invention relates to cleaning processed materials from smooth surfaces, and in particular, to cleaning the surface of rotating rollers in a three roll mill.

### Description of the Related Art

**[0002]** A three roll mill is very effective for evenly dispersing a powdered substance in a liquid or paste. The three roll mill breaks up the agglomerated powder and ensures that the particles are evenly wetted and dispersed throughout the final product, forming suspensions of uniform viscosity. Across a variety of industries, three roll mills are used in the development and manufacture of many products, e.g., paint (dispersion of pigments and additives), ink for screen printing (dispersion of pigments and additives), decorative glass, ceramics, automotive and flat glass, thermo sensitive ink, metal pastes and solders, cosmetics, pharmaceutical ointments, food, adhesive, sealant, polymer, and inks, pastes, and thick films for electronic components.

**[0003]** The individual rollers, or rolls, on the mills need to be thoroughly cleaned between runs. This can be difficult because the materials processed usually have a sticky, pasty or syrupy-like quality to them. In addition, many of the materials processed on the mills are not water-soluble. Removing the residual processing material using a pressure washer with solvents is not a viable option as a user may be faced with a large volume of hazardous and flammable solvents all over the production room.

**[0004]** One way the rollers are cleaned is to disassemble the mill and clean the rollers using a solvent. The process of disassembling and reassembling the mill is time consuming, and using high volumes of solvents can lead to a hazardous working environment and a waste disposal problem. A more popular option for roller cleaning is to use hand wipers (typically industrial paper towels) and clean the rollers on the mill while they are rotating. This typically involves the operator holding a wiper with their hand against the roller while the roller is moving. This is dangerous because if the operator makes a mistake and gets their

hand or fingers in the pinch points, they can suffer a major injury. When cleaning a production size mill with rollers which can be two to five feet long or longer and a foot or larger in diameter, an operator may lose their whole arm as a result of such a mistake.

**[0005]** For companies that process solder paste, thick film paste, conductive ink, silicones, and conductive epoxies there is also a need to keep fibers from the mill and the product. Many companies need to reclaim or dispose of the wipers that are soiled with solvent and the material being processed. In some cases the paste is made up of precious metals or lead so disposal or reclaim is difficult, and typically the soiled wipers are burned.

**[0006]** Similar challenges are faced in other cleaning operations in many industries. Therefore, there is a need to address the above-described health, safety and economic considerations that relate to cleaning surfaces including the surfaces of rotating rollers.

## Summary of the Invention

**[0007]** The invention comprises methods and devices for cleaning surfaces including the surfaces of rotating roller. According to one embodiment, the invention comprises a device for removing residual processed material from the surface of a roller, comprising a support structure comprising a handle having a top palm contact surface, a bottom portion, and a stem portion having a pair of opposed longitudinal concave side surfaces and a pair of opposed substantially parallel latitudinal end surfaces, the surfaces of the stem portion extending from the perimeter of the top surface to the perimeter of the bottom portion, and a substantially wedge-shape deformable base attached to the handle bottom portion comprising opposed longitudinal wiper support surfaces and opposed end surface, and hook and loop fasteners attached to the support structure.

**[0008]** According to another embodiment, the invention comprises a method of recovering processed material from the surface of a rotating roller in a recovery system with a first cleaning device that includes a support structure with a handle having a top contact surface, a bottom portion, and a stem portion that includes a pair of opposed longitudinal concave side surfaces and a pair of opposed substantially parallel latitudinal end surfaces extending from the perimeter of the top surface to the perimeter of the handle bottom portion,

a substantially wedge-shape base attached to the handle bottom portion having deformable opposed longitudinal wiper support surfaces, and fasteners attached to the base, and a first wiper having complementary fasteners and attached to the support structure by the fasteners and covering the wiper support surfaces, comprising placing the first wiper in contact with the processed material on the surface of a rotating roller, allowing the first wiper to absorb an amount of the processed material, placing the first wiper containing said absorbed processed material in a recovery system having a recovery container, and removing absorbed processed material from the first wiper to the recovery container.

**[0009]** In another embodiment, the invention comprises a device for removing residual processed material from the surface of a roller, comprising a support structure, comprising a handle having a top palm contact surface, a bottom portion, and a stem portion having a generally cylindrical side surface extending between the perimeter of the top palm contact surface and the perimeter of the bottom portion, and a deformable base attached to the handle and having a lower wiper support surface, and a plurality of hook and loop fasteners attached to the wiper support surface of the base.

**[0010]** In another embodiment, the invention comprises a recovery system for removing and holding processed material from a cleaning device having a wedge-shaped base with opposed longitudinal wiper support surfaces and an attached removable wiper that covers at least a portion of the wiper support surfaces, comprising a recovery container for receiving and holding the recovered processed material, a dasher disposed inside the recovery container; and a rack disposed on the top surface of the dasher comprising a pair of opposed longitudinal planar surfaces arranged in a wedge-shaped configuration such that the surfaces of the rack substantially contact the wiper of the cleaning device inserted into the rack, and wherein the surfaces of the rack have a plurality of openings that allow fluid from the wiper to pass through the openings and onto the top surface of the dasher.

**[0011]** According to another embodiment, the invention comprises a method of removing residual processed material from the surface of a rotating roller on a three roll mill with a cleaning device that includes a support structure having a handle and a wedge-shape deformable base having opposed longitudinal wiper support surfaces attached to the handle, a wiper removably attached to the wiper support structure and substantially covering the wiper

support surfaces, wherein the wiper is removably attached to the support structure with a fastener, comprising placing the wiper in contact with the processed material on the surface of a rotating roller, and allowing the wiper to absorb an amount of the processed material.

**[0012]** According to another embodiment, the invention comprises a wiper, configured to be coupled with a surface cleaning device that includes a handle having a top palm contact surface, a bottom portion, and a stem portion with a pair of opposed longitudinal concave side surfaces and a pair of opposed substantially parallel latitudinal end surfaces, the surfaces of the stem portion extending from the perimeter of the top surface to the perimeter of the bottom portion, and a substantially wedge-shape deformable base having opposed longitudinal wiper support surfaces and opposed end surfaces attached to the handle bottom portion, and attached hook and loop fasteners, comprising material sized to substantially cover a wiper support surface of the cleaning device, and a plurality of hook and loop fasteners complementary to the fasteners of the cleaning device and correspondingly positioned to mate with the fasteners of the cleaning device to hold the wiper onto the cleaning device.

## Brief Description of the Drawings

**[0013]** The above-mentioned and other features and advantages of the invention will become more fully apparent from the following detailed description, the appended claims, and in connection with the accompanying drawings in which:

**[0014]** Figure 1 is a perspective view of a cleaning device.

**[0015]** Figure 2 is an end view of the cleaning device shown in Figure 1.

**[0016]** Figure 3 is a perspective view of a cleaning device.

**[0017]** Figure 4 is a perspective view of a cleaning device.

**[0018]** Figure 5 is a perspective view of a cleaning device.

**[0019]** Figure 6 is a perspective view of a cleaning device.

**[0020]** Figure 7 is a perspective view of a wiper.

**[0021]** Figure 8 is a perspective view of a cleaning device.

**[0022]** Figure 9 is a perspective view of a cleaning device.

**[0023]** Figure 10 is a perspective view of a cleaning device.

**[0024]** Figure 11 is a schematic representation of a cleaning device in various positions for cleaning a three roll mill.

**[0025]** Figure 12 is a perspective view of a wiper comprising a contact material and a backing material.

**[0026]** Figure 13 is a perspective view of a wiper comprising a contact material and a backing material.

**[0027]** Figure 14 illustrates a mechanical system for using a cleaning device to clean a three roll mill.

**[0028]** Figure 15 illustrates a mechanical system that includes a cart for using a cleaning device to clean a three roll mill.

**[0029]** Figure 16 is a perspective view of a processed material recovery system.

**[0030]** Figure 17 is an side view of the processed material recovery system shown in Figure 16.

**[0031]** Figure 18 is a perspective view of a cleaning device.

**[0032]** Figure 19 is an end view of the cleaning device shown in Figure 18.

**[0033]** Figure 20 a perspective view of a cleaning device.

**[0034]** Figure 21 is a perspective view of the cleaning device shown in Figure 20 with supporting structure.

**[0035]** Figure 22 is a perspective view of the cleaning device shown in Figure 20 with supporting structure.

**[0036]** Figure 23 illustrates placing the cleaning device shown in Figure 20 in various positions for cleaning a three roll mill.

**[0037]** Figure 24 is a flow diagram illustrating a process for cleaning rollers.

## Detailed Description of Certain Inventive Aspects

**[0038]** Embodiments of the invention will now be described with reference to the accompanying Figures, wherein like numerals refer to like elements throughout. The terminology used in the description presented herein is not intended to be interpreted in any limited or restrictive manner, simply because it is being utilized in conjunction with a detailed description of certain specific embodiments of the invention. Furthermore,

embodiments of the invention may include several novel features, no single one of which is solely responsible for its desirable attributes or which is essential to practicing the inventions herein described.

**[0039]** Referring now to Figures 1 and 2, there is shown a cleaning device 2 that includes a structure 13 that includes a handle 10 and a base 60 attached to the handle 10. A wiper 120 is attached to the structure 13. The handle 10 can be made from a variety of materials, for example, plastic or high-density foam. The base 60 is generally wedge-shaped and can be made from a suitable deformable material, for example, high-density foam or non-absorbent high-density foam. The cleaning device 2 can remove processed material from metal or non-metallic surfaces, including the surface of a rotating roller, e.g., a roller in a three-roll mill. The cleaning devices and methods described herein can clean surfaces with or without solvents. When solvents are used, the cleaning devices accordingly comprise solvent resistant materials. The devices and methods described herein are useful for cleaning many other industrial materials, surfaces and containers in a variety of industries.

**[0040]** The handle 10 can include a rectangular bottom portion 16 that has two relatively shorter edges 17, 19 and two relatively longer longitudinal edges 91, 93, a pair of opposed generally parallel end surfaces 22, 24. Each end surface extends vertically from one of the relatively shorter edges 17, 19 of the handle bottom portion 16. A pair of opposed longitudinal concave side surfaces 18, 20 extend upward from the longitudinal edges 91, 93 of the handle bottom portion 16 and extend between the handle end surfaces 11, 24. For cleaning efficiency, length (L) of the cleaning device 2 can be approximately the same length or a little longer or shorter than the roller being cleaned.

**[0041]** The handle 10 also includes a convex palm contact surface 12, extending generally horizontally between the top edges of side surfaces 18, 20 and the top of end surfaces 22, 24. The palm contact surface 12 can be convex so as to contact the palm if the handle 10 is gripped by a hand or contact a mechanical grasping surface if the handle 10 if is held by a mechanical structure, for example, as described in Figures 14 and 15. In other embodiments, the palm contact surface 12 can be a flat surface, or it can be ergonomically shaped to comfortably fit different sized hands. Each of the handle side surfaces 18, 20 includes a side surface contact region 26, 28 below the palm contact surface longitudinal

edges 44, 46. The side surface contact regions provide a concave contact area, at least partially opposed to the palm support surface 12. These contact areas allow fingers and thumbs to exert a gripping force in order to control the cleaning device 2 when the cleaning device 2 is handheld. Additionally, the side surface contact regions 26, 28 can provide a contact area for securely attaching the cleaning device to a mechanical system such as an overhead mechanical device (Figure 14), a mechanical cart cleaning system (Figure 15) or a robot or a robotic cleaning system (not shown).

**[0042]** The handle 10 also includes a stem 30 region, which is generally in the middle of the handle 10. The stem 30 may be configured on different cleaning devices to provide different handle heights, that is, the distance from the palm contact surface 12 to the handle lower portion 16, according to various embodiments. For example, the height of the handle can be approximately 2 – 3 inches high and the overall height of the cleaning device 2 is about 5 - 6 inches. Therefore, during cleaning of a three roll mill, a user's hands may be within about 4 - 5 inches of the rotating rollers. For a small, table-top mill device 4-5 inches may be a safe distance from the roller, but for large three roll mill with heavy rollers that cannot be stopped quickly, placing ones hands 4 – 5 inches from the roller, especially in a pinch point, may be undesirable and unsafe. Configuring the handle 10 to have a longer stem 30 (for example, more than 5 inches) correspondingly increases the distance between a user's hands and the surface being cleaned, e.g., the rotating roller surface of a three roll mill, and can make the cleaning process safer.

**[0043]** As shown in Figure 1, the base 60 includes a top portion 82, configured with a generally rectangular horizontal perimeter and two longitudinal edges 92, 94, that is attached to the handle bottom portion 16, according to one embodiment. The device 2 may also be configured with a handle 10 and a base 60 as one piece, e.g., made integrally from the same material. Handle 10 and the base 60 can be configured to attach together using protrusions that extend from the base upper portion 82 into corresponding recesses in the handle bottom portion 16 or protrusions that extend from the handle 10 into corresponding recesses in the base 60, according to another embodiment. The device 2 may alternatively include a handle 10 and a base 60 that are removably attached, so that either the handle 10 or base 60 may be attached to another base 60, or handle 10, respectively. For example, the

handle 10 and base 60 may be removably attached using hook and loop fasteners, e.g., Velcro®, clips, or another suitable attachment method. For example, Figure 3 shows an embodiment where a cleaning device 3 includes a handle 10A configured with a lengthwise groove 182 that receives a base 60A, that includes side notches 186, 188, where the base 60A may be slid into the end of the groove 182. Figure 3 also shows upper fasteners 78A and 80A and lower fasteners 74, 76 that hold wiper 120.

**[0044]** Referring again to Figures 1 and 2, the base 60 also includes two opposed triangular-shaped end surfaces 108, 110 extending downward from the two shorter sides of the horizontal rectangular perimeter of base top portion 82. The triangular or wedge-shaped end surfaces 108, 110 may be configured with a lower angle 96 (Figure 2) of the triangle typically between 30 and 90 degrees and the upper angles of the wedge 98, 100 may corresponding vary between 75 and 45 degrees. The configuration of angles 96, 98, and 100 may be selected to change the cleaning contact surface the device 2 applies against a surface being cleaned, e.g., a roller, and may correspondingly relate to the size of the item being cleaned. For example, the angles 96, 98, and 100 can be configured to maximize the contact surface the device 2 applies against the rollers on a three-roll mill. In one embodiment for cleaning rollers, the lower angle 98 is about 45 degrees, and the upper angles 98, 100 are each about 67.5 degrees. For some cleaning applications, the base 60 may be configured with the lower angle 96 less than 30 degrees or more than 90 degrees and the upper angles 98, 100 are correspondingly configured to be more than 75 degrees or less than 45 degrees, respectively. Additionally, the base 60 can be asymmetric, for example, configured with upper angles 98, 100 that are not equal.

**[0045]** The base 60 includes two rectangular wiper support surfaces 104, 106 that each extend downward from one of the longitudinal edges 92, 94 and between the triangular end surfaces 80, 82, and form a longitudinal base lower portion 84 where they meet, according to one embodiment.

**[0046]** Base lower portion 84 is shown in Figures 1 and 2 as the lower point of a wedge-shaped base 60. Alternatively, other configurations of the base lower portion 84 can be used. For example, Figures 4, 5, and 6 show perspective views of three cleaning devices 4, 6, and 8 that can be generally configured similarly to cleaning device 2 shown in Figures 1

and 2, but they include different base lower portion configurations and lower fastener configurations, according to different embodiments. Figure 4 shows an example of a cleaning device 4 that includes a base 60B, a base end 110B, upper fasteners 78, 80, lower fasteners 74B, 76B and a convex base lower portion 84B. Figure 5 shows an example of a cleaning device 6 that includes a base 60C, a base end 110C, upper fasteners 78, 80, lower fasteners 74C, 76C and a flat base lower portion 84C. Figure 6 shows an example of a cleaning device 8 that includes a base 60D with a base end 110D, upper fasteners 78, 80, lower fasteners 74D, 76D and a concave base lower portion 84D.

**[0047]** Typically, palm support surface 12 (Figures 1 and 2) can be configured so its longitudinal edges 44, 46 extend over the innermost concave surface point 40, 42 of the handle side surfaces 18, 20. Also, edges 44, 46 do not typically extend horizontally over the longitudinal side edges 92, 94 of the base 60. This configuration allows a hand grasping the handle 10 to place the palm against the palm contacting surface 12 and curl the fingers and the thumb around the longitudinal edges 44, 46 so that the fingers and thumb easily contact the side surface contact regions 26, 28. However, in some embodiments the handle 10 is configured so that the longitudinal edges 44, 46 do extend over longitudinal edges 92, 94 of the base 60. For example, if the overall size of the cleaning device is small, a larger palm contact surface 12 allows a user to more securely or more comfortably hold the cleaning device 2. Alternatively, as exemplified in Figure 9 and described further below; the palm support surface 12 may be of a different shape.

**[0048]** The wiper support surfaces 104, 106 each include a middle support region 62, 64 that provides a firm and deformable back support surface for the wiper 120 where it contacts the surface being cleaned. The cleaning device 2 also includes upper fasteners 78, 80 that are attached to the upper region 66, 68 of the wiper support surfaces 104, 106 near the longitudinal edges 92, 94 of the base top portion 82. The cleaning device also includes lower fasteners 74, 76 that are attached to the lower regions 70, 72 of the wiper support surfaces 104, 106 near the base lower portion 84. Figures 4, 5 and 6 show examples of other locations of the upper fasteners 78, 80 and lower fasteners 74, 76 for the differently shaped base lower portions 84B, 86C, 84D respectively, according to other embodiments.

**[0049]** The upper fasteners 78, 80 and lower fasteners 74, 76 fasten a wiper 120 (Figure 2) to the base 60. According to one embodiment, the upper fasteners 78, 80 and lower fasteners 74, 76 comprise hook and loop fasteners. The wiper 120 also includes complementary hook or loop fasteners suitably located to allow the hook and loop fasteners of the wiper 120 to mate with the corresponding upper and lower fasteners 74, 76, 78, 80 on the base 60 and fasten the wiper 120 to the base 60. The upper and lower fasteners 74, 76, 78, 80 may be attached to the base 60 and the wiper 120 by various means, including heat sealing, adhesive, or stitching.

**[0050]** The wiper 120 can be made from a variety of materials, for example, cloth, paper, foam, an abrasive material e.g., polycarbonate, an abrasive material with a backing material, e.g., foam, and polyester with a foam backing material, and is preferably comprises non-scratching, non-scoring materials.

**[0051]** As shown in Figure 7 the wiper 120 is typically a thin, rectangular, sheet-like shape that includes two broad surfaces 122, 124 and four rounded corners 126, 128, 130, 132. The broad surfaces contribute most of the surface area of the wiper 120. The surface 122 can include strips of hook and loop fasteners 133, 136 that are positioned near and generally parallel to lengthwise edges 125, 127 and strips of hook and loop fasteners 134, 135 positioned along the center of the wiper 120 and parallel to lengthwise edges 125, 127. The hook and loop fasteners 133, 134, 135, 136 are complementary to the hook and loop fasteners 78, 74, 76, 80 that are attached to the base 60 (Figure 2) and positioned in corresponding locations. The fasteners are positioned to securely attach the wiper to the base 60 and conform the wiper to the shape of the surface it covers.

**[0052]** The wiper 120 can be made from a variety of materials including an open cell, hydrophilic, static-dissipative, polyurethane foam. One such material is described in U.S. Patent No. 6,004,640, HYDROPHILIC FOAM ARTICLE AND SURFACE-CLEANING METHOD FOR CLEAN ROOM. The material described in the '640 patent is available from Foamex Asia WCC of Carlsbad, CA, and is sold commercially as an UltraSORB® wiper.

**[0053]** Figures 8 and 9 show examples of two cleaning devices 3, 5 where the base 60E of each cleaning device 3, 5 are similar but the handles 30E, 30F are configured

differently. Figure 8 shows a cleaning device 3 that includes a handle 10E and a base 60E. The handle 10E includes a horizontal circular lower portion 16E, a convex palm contact top surface 12E with a raised center region 14E, and a cylindrical concave side surface 18E extending between the lower surface 16E and the palm contact top surface 12E. The side surface 18E includes a finger and thumb contact region 26E that provides a surface at least partially opposed to the top surface 12E for gripping the cleaning device 3. A handle stem 30E may be configured to be of varying heights in different cleaning devices to ensure a suitable safe distance is maintained between a surface being cleaned and hand holding the handle. The palm contact surface 12E has a circular perimeter edge 46 that typically extends horizontally outward past the innermost concave point 40E of side surface 18E. The handle bottom portion 16E is generally the same size, in contact with and is joined to a base upper surface 82E. According to one embodiment, the base 60E and the handle 10E are integrally made from the same material, i.e., the handle and the base are manufactured as one piece and do not need to be joined.

**[0054]** The base 60E includes a horizontal circular bottom surface 88E, and a cylindrical side surface 112 that extends vertically between the base lower surface 88E and a base upper portion 82E. A circular or disk shaped fastener 74E is attached to the base lower surface 88E by, for example, heat sealing, gluing, or stitching, and fastens a circular or disk shaped wiper 120E to the cleaning device 3. For example, according to one embodiment, the fastener 74E comprises hook and loop fasteners, and the wiper 120E also comprises complementary hook and loop fasteners.

**[0055]** Figure 9 shows a cleaning device 5 that has a base 60E configured similarly to base 60E of the cleaning device 3 shown in Figure 8, but with a different handle configuration. The handle 10F includes a horizontal circular lower portion 16E attached to a larger circular top base surface 82E. A cylindrical handle stem 30F extends upwards and attaches to a larger circular surface contact region 26F, which is the lower surface of handle top portion 48. The handle top portion 48 includes a top generally flat palm contact surface 12F and a cylindrical side surface 52 that extends between the lower surface of handle top portion 40 and the palm contact surface 12F. The diameter of the surface contact region 26F is typically smaller than the diameter of the top base surface 82E. However, in some

embodiments the diameter of the surface contact region 26F may be larger than the diameter of the base top portion 82E, e.g., for smaller cleaning devices. The edges 114, 116, joining the palm contact surface 12F, the cylindrical side surface 52 and the lower surface of the handle top portion 48 can be rounded, as shown in Figure 9, to provide the users a more ergonomic and comfortable handle. In another embodiment, the intersection of the palm contact surface 12F, and the cylindrical side surface 52, and the intersection of the cylindrical side surface 52 lower surface of the handle top portion 48 may form substantially right angles.

**[0056]** Generally, the two cleaning devices 3, 5 are used by holding the device in one hand and placing the wiper 120E in contact with the surface of the surface to be cleaned. When holding the cleaning devices 3, 5, the palm of the hand is placed against and is supported by the palm surface 12E, 12F. The fingers and thumb of the hand wrap around the palm surface edge 45, 45F and are placed in contact with and apply pressure to the surface contact regions 26E, 26F, respectively.

**[0057]** Figure 10 shows a cleaning device 7 that includes a handle 10 with concave side surfaces 18, 20 configured similarly to the cleaning device 2 shown in Figure 1. The handle 10 has a base 60F with wiper support surfaces 104, 106, and a wiper 120F covering the support surfaces 104, 106 and covering a portion of the handle side surfaces 18, 20. The wiper 120F may comprise any of the wiper materials described herein. The base 60F is similarly configured to the base 60 of cleaning device 2, except that the base 60F does not have attached upper and lower fasteners for attaching the wiper 120F. Instead, cleaning device 7 includes clips 150, 152, 154 that attach the wiper 120F to the handle 10. Each clip includes two generally opposed concave vertical clip arms 158, 160 and a connecting clip top member 162 that extends between the clip arms 158, 160. The concavity of the clip arms 158, 160 can be shaped similar to the concavity of the handle side surfaces 18, 20 and the curvature of the clip top member 162 can be shaped similar to the convexity of the palm contact surface 12. The clips 150, 152, 154, shown partially in a ghost view, may be fabricated from plastic, metal or another suitable material. The arms of the clips 158, 160 extend downward past the upper edge 164 of the wiper 120F and securely fasten the wiper 120F by pinching it tightly against the handle side surfaces 18, 20. Figure 10 shows cleaning

device 7 includes three clips 150, 152, 154, however, more clips or fewer clips may be used, according to other embodiments, and the number of clips may relate to the length of the cleaning device 7.

**[0058]** Figure 11 is a schematic representation of a typical three roll mill configuration, where the three rolls are positioned parallel to one another in a horizontal plane. An apron roll 192 is positioned on the left side of a center roll 191 and a feed roll 190 is positioned on the right side of the center roll 191. A small gap separates the surfaces of each adjacent roll. During mill operation and during cleaning, each roll rotates in the opposite direction from the adjacent roll, e.g., the feed roll 190 rotates counterclockwise, the center roll 191 rotates clockwise, and the apron roll 192 rotates counterclockwise. A pinch point defines the edge of an area, relative to the rollers, of the most dangerous part of the three-roll mill, inside of which the rollers tend to pull an object into the gap between the rollers. For example, the point at the top of the center roll and the top of the feed roll generally are considered pinch points. The pinch points can be defined even farther from the gap between the feed roller and the center roller for safety reasons. Typically, no objects are placed past a pinch point while the rollers are rotating. Figure 11 also shows examples of the placement positions and orientation of cleaning devices 2, 2 , 2 to clean the roll surfaces of a three roll mill, including placing the devices past the roller pinch points, according to various embodiments. The cleaning devices of this invention can be used in many other positions to contact and clean roll surfaces of a three-roll mill or other surfaces. The positions shown in Figure 11 and described below are only examples of the many ways the cleaning devices of this invention may be used.

**[0059]** At cleaning position one the cleaning device 2 is in a vertical orientation and positioned above and between the apron roll 192 and the center roll 191. The longitudinal axis of the cleaning device 2 is approximately aligned in parallel with the longitudinal axis of the rolls 192, 191. The base bottom edge 84 is vertically aligned with the gap between the surfaces of the apron roll 192 and the center roll 191. The cleaning device 2 is positioned so that the broad surfaces of the wiper 120 contact both the apron roll 192 and the center roll 191 and cleans the roll surfaces as they rotate. The base 60 can be made from a deformable material that allows it to conform at least partially to the curvature of the roll

surface to maximize the surface contact area of the wiper 120 with the roll. A downward force can be applied to the handle 10 of cleaning device 2 so the wiper 120 can suitably contact the surfaces of the rolls 191, 192 for cleaning. For example, if an absorbent wiper 120 e.g., foam, is used, a relatively lesser downward force can be applied so the wiper 120 lightly contacts the rolls 191, 192 and absorbs processing material residing thereon. If the wiper 120 is abrasive, a relatively greater force can be applied so the wiper 120 contacts the roll surfaces with enough force to allow the wiper 120 to remove the residual processing material on the roll surfaces.

**[0060]** At cleaning position two the cleaning device 2 are placed in a position to clean the surface of the center roll 191 and the surface of the feed roll 190, according to one embodiment. To decrease the time required to clean a three roll mill, cleaning devices 2, 2 can be used simultaneously in cleaning positions one and two, respectively, on the same mill. The relative orientation and position of cleaning device 2 is similar to that as described for the cleaning device 2. Generally, placing an object, e.g., a rag, in the area above and between the feed roll 190 and the center roll 191, i.e., cleaning position two, is dangerous. The rotation of the center roll 191 and the feed roll 190 towards each other tends to pull the object through the rolls and can result in harm to the operator or the machine. However, cleaning device 2 may be placed in cleaning position two and effectively and safely used to simultaneously clean the center roll 191 and the feed roll 190.

**[0061]** Cleaning position three illustrates positioning cleaning device 2 in a generally horizontal position to clean processing material off of the feed roller 190. Cleaning position three is a typical position for cleaning the feed roller 190 as it keeps the cleaning device 2 and the user holding the cleaning device 2 away from the dangerous area between the center roll 191 and the feed roll 190. The cleaning device 2 is placed in cleaning position three with a broad side of the wiper 120 in contact with the surface of the feed roll 190.

**[0062]** An example of an abrasive wiper 120C is shown in Figure 12. Wiper 120C includes an abrasive contact layer 144 laminated to a deformable backing layer 142A. The abrasive contact layer 144 can be made from a non-scratching non-scoring material, e.g., polycarbonate, and is placed outwardly on the base 60 to contact the surface being cleaned.

The deformable backing layer 142A can be made from a suitable deformable material, e.g., foam, and is placed inwardly on the base. In one embodiment, the deformable backing layer 142A includes a fastener, e.g., hook and loop fasteners, that fastens to a corresponding fastener on the base 60 and holds the wiper 120C on the base 60.

**[0063]** According to one embodiment, cleaning device 2 includes a laminated wiper 120B, as shown in Figure 13. Wiper 120B includes a contact material 140 that contacts the surface of a roll, and a backing material 142 that can be attached to and contacts the base 60. According to one embodiment, the contact material 140 is polyester and the backing material 142 is foam, e.g., as described in the '640 patent. In one embodiment, the backing material 142 includes a fastener, e.g., hook and loop fasteners, that fastens to a corresponding fastener on the base 60 and holds the wiper 120B onto the base 60. Using a laminated wiper 120B can minimize the "pulling" effect of the center roll 191 and the feed roll 190 on the cleaning device and can allow the cleaning device 2 to be employed in cleaning position two. Alternative designs for the base, as shown in Figures 4, 5 and 6 may also minimize the "pulling" effect of the center roll 191 and feed roll 190.

**[0064]** The cleaning device can be hand held, or held by a mechanical system. Figures 14 and 15 illustrate embodiments of mechanical systems that can be used to hold one or more cleaning devices for cleaning a three-roll mill. These embodiments include structure to hold a cleaning device, place the cleaning device in contact with a roll surface, apply force to the cleaning device to suitably press the cleaning surface of the cleaning device against the surface of the roll, and remove the cleaning device from the roll surface. While Figures 14 and 15 show two embodiments, many other embodiments of mechanical structure for holding and employing the cleaning device that are not shown herein can be used.

**[0065]** Figure 14 shows an overhead system 200 that holds one or more cleaning devices 26, 26 above a three roll mill and employs the cleaning devices 26, 26 to remove processed material from the surfaces a three roll mill 201. The three-roll mill 201 is illustrated in Figure 14 by the apron roll 192, the center roll 191, and the feed roll 190. The system 200 includes vertical two guide members 208, 210 attached to and extending down from a top horizontal support member 212. A lifter 202, generally positioned parallel to and between the guide members 208, 210, and is attached at its upper end to and extends

downward from the support member 212. The lower end of the lifter 202 is attached to a cross member 212 that horizontally extends between and is slidably connected to the guide members 208, 210 by fittings 204, 206. The lifter 202 includes a lifting adjust component 216 and a lifting spring 218, and is used to provide an adjustable lifting force for the portion of the system 200 attached to cross member 214 making it easier to raise and lower the cleaning devices 2, 2. Fitting 204 is attached by a connecting member 205 to a locking component 242 that engages a vertical locking member 240, which is attached to and extends downward from the horizontal support member 212. The locking component 242 can lock the fittings 205, 206 and the cross member 214 in a position along guide members 208, 210, for example, to place the connected cleaning devices 2, 2 in contact with the rolls 190, 191, 192. A handle 246 and a connecting member 244 extending between the handle 246 and the locking component 242 allow a user to manually position the cleaning devices 26, 26, assisted by the lifter 202, and engage or disengage the locking component 242. Other embodiments can include, for example, additional guide rods or a plurality of lifters, which may be advantageous for large embodiments of an overhead system.

**[0066]** The system 200 also includes extendable members 220, 222 with upper ends attached to the horizontal cross member 214. Extendable members 220, 222 extend downward from the horizontal cross member 214 and are attached on their lower ends to a cleaning device holder structure 224. The holder structure 224 includes clamping devices 226, 228 configured to attach to the handles 10, 10 of the cleaning devices 2, 2 using clamp arms 230, 232, 234, 236. For example, the clamp arms 230, 232 of clamping device 226 hold cleaning device 2 by closing against the side surface contact regions 26, 28 of the handle 10. The clamp arms 234, 236 hold cleaning device 2 by closing against the side surface contact regions 26, 28 of the handle 10. The extendable members 220, 222 include adjustable springs 221, 223. The adjustable springs can be adjusted to apply a suitable downward force to press the wipers 120, 120 of cleaning devices 2, 2 against a roll when the cross member 214 is locked in place so that the cleaning devices 2, 2 contact the roll. The clamping devices 226, 228 can be configured to release a hold-cleaning device if the cleaning device is pulled through the rolls.

**[0067]** Figure 15 shows a movable mechanical system 300 for holding a cleaning device 2 that includes a box-shaped cart 330. The cart 330 can include wheels 312 to make it easily movable, and an inside compartment for storing, for example, roll cleaning supplies, accessed by a door 316 that is opened using a handle 328. A vertical support member 304 is attached to the top surface 310 of the cart 330 and extends vertically upward, and is supported by attached angled members 306, 308 that are also attached to the top surface 310 of the cart 330. A locking slidable mount 332 is attached to and rides along the vertical support member 304. The slidable mount 332 can lock attached horizontal support member 334, 336 at a desired position on the vertical support member 304 onto the vertical support member 304. Horizontal support members 334, 336 are attached on a first end 331 to the slidable mount 332 and extend for a distance horizontally away from the vertical support member 30. The top end of an extendable member 340, shown partially in a ghost view to show a spring 341, is pivotally attached by a fastener 338 to a second end 333 of the horizontal support members 334, 336, and extends vertically downward from the support members 334, 336. Fastener 338 can allow some movement of the cleaning device 2 when it is lowered onto the rolls which can help position the wiper 120 to contact rolls without moving the cart 330. The lower end of the extendable member 340 is attached to a clamp 342. The clamp 342 is configured to removably attach to a handle 10 of a cleaning device 2. The surface 339 of clamp 342 is configured to generally conform to the shape of the handle 10 and preferably contacts both the palm contact surface 12 and the side surface contact regions 26, 28. The clamp 342 can be configured to release the handle 10 if a large downward force is applied to the cleaning device 2, e.g., if the cleaning device is pulled between the rolls.

**[0068]** The system 300 can include a lifter support member 344 that is attached to the vertical support member 304 and extends horizontally above and generally in parallel with the support members 334, 336. A lifter 346 is attached between the lifter support member 344 and the horizontal support members 334, 336. The lifter 346 provides a lifting force on the support members 334, 336 so that the support members 334, 336 and the connecting structure can be easily moved up and down the vertical support member 304. A handle 350 is connected to the locking slidable mount 332 by a connecting member 348 and

provides a user the means to raise or lower the cleaning device 2 and lock it into a desired position.

**[0069]** The system shown in Figure 15 can mechanically hold the cleaning device 2 and move it into a cleaning position above a roll, lower the cleaning device 2 so that it contacts the apron roll and the center roll and lock it into place. The extendable member 340 applies a suitable downward force to the cleaning device 2 to keep it in proper contact with the rolls during cleaning. After a time, the system 300 can raise the cleaning device 2 away from the rolls to allow the wiper 120 to be cleaned or replaced, and then the system 300 can either continue cleaning the same rolls or be moved to clean another roll. In another embodiment, the cleaning device holding mechanism can be configured to move along the horizontal support members which will allow positioning of the cleaning device without moving the cart, e.g., when moving a cleaning device from one cleaning position to another cleaning position.

**[0070]** Figures 16 and 17 illustrate a processed material and solvent recovery system 450. The sponge-like nature of foam greatly enhances the reclaim or disposal process as the processed material/solvent can be removed out of the wiper and collected in a "dirty rinse" or recovery container. This allows re-use of the wiper and can greatly reduce the number of wipers needed, resulting in a reduction of disposal costs. In addition, collecting the majority of the processed material in solution with the solvent reduces the quantity of hazardous solid waste. This separation of waste streams further reduces the cost of the reclaim or disposal process. Figure 16 shows a perspective view of the system 450 for recovering processed material and solvent from wiper recovery system 450. Figure 17 shows the same system 450 from an end view and includes illustrates receiving cleaning device 2 in the system 450. Figures 16 and 17 both show a ghost view of the extendable members 480 and springs 482 that are disposed inside the container 464.

**[0071]** The recovery system 450 includes a container 464 for collecting and temporarily storing the processed material and solvent removed from the wiper 120 attached to cleaning device 2. A dasher 478 fits inside the container 464 and a rack 466 is removably connected to the top surface 468 of the dasher 478 for receiving the cleaning device 2. The dasher 478 saturates or immerses the cleaning device 2 in a solvent contained within the

container 464 when the cleaning device is pressed into the rack 466. According to one embodiment, the dasher includes three extendable members 480 that are attached to and extend between the perforated top surface 468 of the dasher and the bottom surface of the container 469. Springs 482 in the extendable members 480 extend to normally position the perforated surface 468 near the rim 470 of the container 464, and compress allowing the rack 466 to be pushed down into solvent. The perforated surface 468 serves as a metal flash arrester and protects the contents against fire and, together with a hinged cover 474, serves to reduce escape of vapors and evaporation losses.

**[0072]** The container 464 includes a vertical cylindrical side surface 465 attached to a generally flat bottom surface 467 in a manner as to provide a leak-proof connection and is preferably made from metal or another suitable solvent resistant material, e.g., a solvent resistant plastic. The top surface 468 includes a plurality of openings 472 and can be at least slightly recessed below the rim 470 of the container 464, according to one embodiment. The top surface 468 generally covers and contains the contents of the container 464, and allows the passage of solvent and processed material into the container 464 through the openings 472. The cover 474 can be pivotably attached to the container 464 by hinge 476 and closes to seal the container 464 if the rack 466 is removed, for example, when the container is full or not in use. Locking mechanism 451 can tightly secure the cover 474 over the top of container 464 allowing the container 464 to be moved without spilling its contents.

**[0073]** The container 464 can vary in size and preferably its diameter will be greater than the length of the rack 466. According to other embodiments, the container 464 may be rectangular or square, or another suitable shape to accommodate the length of the rack 466, and in these embodiments can include a correspondingly shaped dasher to fit into the container. For example, when a long cleaning device 2 is used to clean long rollers, the container 464 and the rack 466 can also be long enough to accommodate the cleaning device 2, for example, the container 464 can be an elongated trough-like shape several feet of more in length.

**[0074]** The rack 466 includes substantially vertical support members 452 that support and hold the rack 466 above container 464, and opposed rectangular waste removal surfaces 456, 457. As shown in Figures 16 and 17, the upper portion 354 of each support

member 452 is attached to the waste removal surface 456 or 457, and the lower portion 456 of each support member 452 is removably connected to the container 464, according to one embodiment. The support members 452 can also hold the rack 466 above a container 464 by spanning the container 464 so that the lower portions 456 rest on a surface, e.g., a floor, that can be supporting both the container 464 and the rack 466, according to another embodiment.

**[0075]** The waste removal surfaces 456, 457 are typically rectangular planar surfaces with parallel longitudinal axes. The removal surfaces 456, 457 include a plurality of openings 461 allowing solvent and processed material accumulated on and absorbed in the wiper 120 to pass through the waste removal surfaces 456, 457 by way of the openings 461 and into the container 464. The waste removal surfaces 456, 457 are typically configured in accordance with the shape of the cleaning device. In one embodiment, the surfaces 456, 457 are configured in a "V"-shape so that the upper edges 458, 459 of the waste removal surfaces 456, 457 are separated and the lower edges 459 are close together or connected. This configuration allows the rack 466 to receive a cleaning device 2 through the open area between the upper edges 458, 459, as shown in Figure 17. The angle 460 formed by the "V" configuration of the waste removal surfaces 356 generally corresponds to the angle 96 (Figure 2) of the base 60 on the cleaning device 2. When the cleaning device 2 is inserted into the rack 466, the broad surfaces of the wiper 120 contact the waste removal surfaces 356, 457. The rack 466 may also be configured to receive other shapes of cleaning devices, such as those shown in Figures 8 and 9.

**[0076]** When the cleaning device 2 is inserted into the rack 466 and a downward force is applied to the handle 10, the wiper 120 is compressed between the base 120 and the waste removal surfaces 456, 457. This causes the solvent and processed material contained on and absorbed in the wiper 120 to pass through the plurality of openings 461 into the container 464. The downward force also pushes the cleaning device 2, the surface 468 and the rack 466 lower into the container 464, immersing the cleaning device 2 in the solvent contained therein which further removes the processed material from the wiper 120G.

**[0077]** Referring now to Figures 18 and 19, a cleaning device 9 is shown, according to another embodiment. Cleaning device 9 includes a base 60 and handle 10 structure 13 that can be configured as previously described for cleaning device 2 (Figures 1

and 2). Cleaning device 9 also includes a wiper 120G that covers and contacts portions of the side surfaces 104, 106 of the base 60 and the side surfaces 18, 20 and palm contact surface 12 of the handle 10. Wiper 120G can be cylindrical sleeve that is formed, for example, by attaching the two longitudinal edges of a flat wiper of a suitable size, or it can be a sleeve specially made to fit the cleaning device surfaces that it covers. Wiper 120G comprises a suitable stretchable material, e.g., foam or cloth, so that it can expand as it is placed over the handle/base structure and then contract to conform to the underlying surfaces of the base 60 and handle 10.

**[0078]** The cleaning device 9 also includes a clip 500 that holds the wiper 120G in place on the base 60/handle 10 structure 13. The clip 500 includes wiper contact portions 502 that contact the outer side 508 of wiper 120G at various points and press wiper 120G firmly against a portion of the underlying surface of handle 10. Arc-shaped spring members 504 on each end of the clip 500 span a top portion of the handle 10, connecting opposed contact portions 502 and providing, when flexed, a mechanical force that presses the contact portions 502 against the wiper 120G. Longitudinal support members 506 are aligned parallel to the longitudinal axis of the structure 13 and are disposed between and connect the spring members 504. According to another embodiment, the clip can be a plurality of clips that hold wiper 120G in place, e.g., clips 150, 152, 154 in Figure 10.

**[0079]** Referring now to Figure 20-23, a cleaning device 11 is shown that includes a cylindrical structure 13H having a cylindrical outer surface 550 and a wiper sleeve 120H that fits over, tightly covers, and makes contact with the cylindrical outer surface 550. The structure 13 and the wiper 120H can be made from any of the structure or wiper materials as described herein. For example, the structure 13 can comprise non-absorbent high-density foam and the wiper can comprise absorbent solvent resistant foam. The structure 13H has opposed parallel donut shaped end surfaces 553 connected on an outside perimeter by the outer surface 550 and on an inside perimeter by an inner cylindrical surface 551 that is equidistant from outer surface 550. Figure 20 shows a ghost view of the surface 551, and Figures 21 and 22 show a ghost view of the axial members 566, 556, respectively.

**[0080]** The cleaning device 11 can be attached to a support arm 558 (Figure 21). The support arm can be held by a user or a mechanical device to safely and properly position

the cleaning device so that the wiper outer surface 564 can make contact with the surface of a roller. The support arm 558 includes an axial member 566 that extends along the longitudinal axis of the cleaning device 11. The axial member is removably attached to end surfaces 553 by fittings 554 that are disposed in the center of the end surfaces 553. The fittings secure the cleaning device 11 to a position along the member 556 and allow the cleaning device 11 to rotate around the axial member 556. According to another embodiment, the fittings 554 secure the cleaning device 11 to the axial member 566 so that the cleaning device cannot rotate. A handle 568 connected to the axial member 566 and extending generally perpendicular to the axial member 566 provides a holding surface 559 for the user of mechanical device to safely hold and position the cleaning device 11

**[0081]** The cleaning device 11 can also be positioned using an overhead support structure 570, as shown in Figure 22 according to one embodiment. The overhead structure 570 can be, for example, similar to the overhead structures shown in Figures 14 and 15, and can include a variety of structures to hold the device 11 in contact with the cleaning surface. Structures similar to those described herein can also be used to hold the cleaning device in other cleaning positions, e.g., on the top or on the side of a rotating roller. As shown in Figure 22, the structure 570 can include an axial member 556 that disposed through the longitudinal axis of the cleaning device 11 and connected to the cleaning device 11 by fasteners 554 such that the cleaning device 11 can freely rotate. According to another embodiment, the axial member 556 comprises two pieces that are each disposed through the longitudinal axis but not connected to each other, i.e., each piece running only part way through the cleaning device 11. In another embodiment, the axial member 556 fastens securely onto the cleaning device 11 and the axial member 556 is configured to rotate with the attached cleaning device. Vertical members 560 connect the axial member 556 to a horizontally disposed support member 562. Extendable members 220, 222 connect the structure 570 to further overhead structure (not shown), and can provide a suitable downward force that presses the wiper 120H against the surface of a roller.

**[0082]** Figure 23 illustrates placing the cylindrical-shaped cleaning device 11 in different cleaning positions on a three roll mill, according to one embodiment. For example, the cleaning device 11 can be placed in contact with the apron roll and the center roll

(position one), the center roll and the feed roll (position two), and/or on the side of the feed roll (position three). The cleaning device 11 can be positioned in many other cleaning positions, and Figure 23 should not be viewed as limiting the placement of the cleaning device for cleaning roller surfaces. In any cleaning position, the cleaning device 11 can configured to either rotate, where the rotation can be caused by the friction between the roller and the cleaning device or not rotate.

**[0083]** Figure 24 illustrates a process 600 for removing and recovering processed material from the surface of a roller, including the rotating rollers of a three roll mill, according to one embodiment. Devices described herein or other suitable devices can be used to carry out this process 600. Although this process is directed towards cleaning and removing processed material from a surface of a rotating roller, the method can be applied to a wide range of surfaces, including containers, industrial work surfaces, floors, walls, rollers of many types, that are found in many industries.

**[0084]** At step 602, a wiper is placed in contact with the processed material on the surface of a rotating roller. The wiper can made from any material described herein, e.g., cloth or foam, and of any shape, for example, a rectangular sheet, a cylindrical sleeve, or disc-shaped. The wiper can be attached to and covering a structure that has flat or curved wiper support walls.

**[0085]** At step 604, the wiper is allowed to absorb at least some of the processed material. If a large amount of processed material exists on the roller, the wiper may not be able to absorb all the processed material and additional applications of the wiper to the surface can be necessary.

**[0086]** At step 606, the wiper containing the absorbed processed material is placed in a recovery system. One embodiment of a recovery system with a recovery container was previously described herein and shown in Figures 16 and 17. The wiper can be placed in a recovery system that is configured to accommodate the full length of the wiper.

**[0087]** The absorbed processed material is removed from the wiper to a recovery container at step 608. One way the absorbed material can be removed is to press the wiper firmly into a rack that has sides configured to conform to the surfaces of the wiper. Pressing the wiper down compresses the wiper and forces an amount of the processed material out of the

wiper. The rack can be placed on the top of a dasher that sits in the recovery container for ease of use. Allowing solvent to interact with the wiper further facilitates removing non water-soluble processed material from the wiper.

**[0088]** At step 610, a determination is made as to whether the roller surface is sufficiently free of processed material, and if it is, the process proceeds to step 612 and ends. If the roller surface is not free from processed material, the cleansed wiper can be reused and again be placed in contact with the surface of the roller, as in step 602. The process can be repeated until the surface of the roller is sufficiently clean.

**[0089]** The devices and methods described herein details certain embodiments of the invention. It will be appreciated, however, that no matter how detailed the foregoing appears in text, the invention can be practiced in many ways. As is also stated above, it should be noted that the use of particular terminology when describing certain features or aspects of the invention should not be taken to imply that the terminology is being re-defined herein to be restricted to including any specific characteristics of the features or aspects of the invention with which that terminology is associated. The scope of the invention should therefore be construed in accordance with the appended claims and any equivalents thereof.